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SANDWICH COMPONENT FOR THERMAL INSULATION

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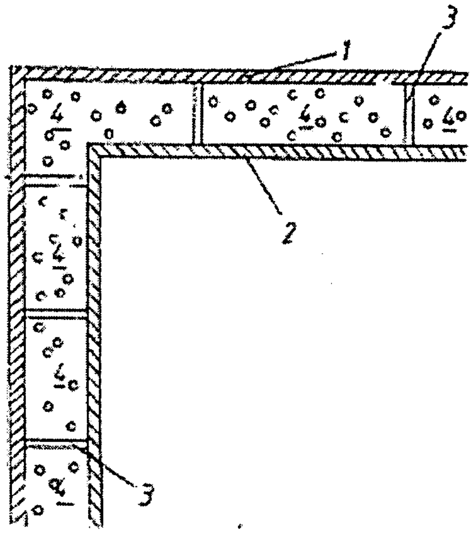
[Abstract]

With a sandwich element, made up of two plates (1, 2) forming the outside surface, and a core located in-between, the proposal is made that the core be made of super-insulating aerogel (4) (= low-density aerogel).



Description

The invention concerns a sandwich component for thermal insulation, consisting of two plates, which form the outside surfaces, and a core, which is located inbetween.

From the area of light construction, the use of sandwich components is generally common and they are frequently used for the production of aircraft, aircraft parts, boat hulls, car walls, and furniture, and they are universally employed in other areas. The sandwich mode of construction is characterized in that a core is located between two plates, which are arranged at a distance from one another and which form the outside surfaces, wherein the two plates are, with respect to strength, under high stress and for this reason, are made, for example, of metal plate, plywood, plastic material, and the like, and in between, the core is placed for spacing and to improve the usage characteristics. It frequently consists of a light supporting layer, which is formed by foam, balsa wood, or other light materials with compact as well as diversely dispersed structures or also with a honeycomb core made of paper, plastic, or light metal. The advantage to the sandwich mode of construction in comparison with solid wall, massive, metal, or wood modes of construction lies in the considerable reduction of the mass, a better dimensional stability, a frequently equivalent or even greater strength, and a mostly better heat and sound insulation. Mainly, the increased technological expense is regarded as a general disadvantage. In recent times, with the use of sandwich elements produced using foam materials, it is considered a substantial disadvantage that CFCs (= chlorofluorocarbons) are found in the pores of the foam material, which are released successively with time to the outside and thus to the atmosphere. Only by very recent findings was a connection established between the use of CFCs or their release to the atmosphere and the destruction of the ozone layer of the earth. As is known, the ozone layer has an extraordinarily important function for the health of humans, which consists in absorbing, to a large extent, UV light arriving from the sun and to keep it from striking the surface of the earth. An increase in the UV radiation dosage causes a more frequent appearance of skin diseases, the triggering of skin cancer, and the like. As is shown by calculations, an ozone decline of approximately 1% results in the fraction of UV radiation on the surface of the earth increasing by ca. 2%, whereby the frequency of skin cancer diseases increases by approximately 5%. As a result of the environment-endangering effect of CFCs, massive political efforts are being undertaken to prohibit, as soon as possible, the production and use of CFCs and CFC-containing products, which also include hard and soft foams.

Proceeding from this, the invention has as its goal the creation of a sandwich component that has a high thermal insulation capacity and does not endanger the environment.

This goal is attained, in accordance with the invention, in that the core of the sandwich component is made of a super-insulating aerogel (= low-density aerogel). The term "aerogel" designates special solids consisting of a large number of cavities or pores with very small diameters. In contrast to foamed materials, it has an open-pore structure--that is, the individual pores are connected to one another. As a function of its structure, their diameter is 1, 10, 15 nm. In contrast to foamed materials, the solid fraction is small. The material is basically arbitrary.

Production is carried out in such a manner that first a gel is obtained in a sol-gel process, which subsequently produces the desired material by super-critical drying. The "hot" super-critical drying of a gel with alcohol (by exchanging the gel water with alcohol) in the pressure and temperature range above the critical point (for example, with methanol, a pressure greater or equal to 68 bar, a temperature greater or equal to 260 degrees Celsius) and the "cold" super-critical drying with (liquid) carbon dioxide, which is exchanged with the gel water via alcohol or acetone (pressure greater or equal to 78 bar, temperature greater or equal to 32 degrees Celsius) are technically important. This type of drying requires high technical expense due to the use of autoclaves and a time- and energy-consuming operation. If no special demands for transparency are made, the production of an aerogel from silicon dioxide, which is obtained from water glass, is decisively advantageous. It can be produced both in the form of blocks as well as granules with particle sizes with diameters of 1-6 mm.

The thermal insulation capacity of the obtained aerogels can vary and is influenced by the density. Maximum values are obtained with so-called super-insulating aerogels, wherein low-density aerogels are understood.

An obstacle to the practical use of aerogels is their difficult processability. The mechanical characteristics are deficient; when processed, the aerogel material decomposes into very small particles; the dimensional stability is very low and a cementing is basically difficult.

Nevertheless, the use of such sandwich components is of considerable advantage, since there is no concern regarding an endangerment of the environment, production is comparable in cost to foamed cores, and in contrast, the thermal insulation capacity is increased.

In an appropriate refinement, the use of undoped aerogel is recommended in sandwich components in the low-temperature range—that is, at temperatures below 300 K.

In the high-temperature range, on the other hand—that is above 300 K—the use of doped aerogels, designated occasionally as turbid, is recommendable. They are formed by doping the aerogel with certain materials, among which are iron oxides (FeO), titanium oxide (TiO) and others. In this way, the absorption edge is shifted approximately between 2 and 4 micrometers, so that they are suitable for insulation in high temperature ranges. The turbidity agents stop the comparatively high transparency in the medium infrared and bring about a suppression of the radiation heat transport, which predominates, in particular, with vacuum super-insulations.

With regard to the physical nature of the aerogel material to be introduced between the plates, as a core, various solutions are possible: thus, in principle, the production of aerogels as a solid block and its introduction between the plates are conceivable. The advantage of this mode of construction is to be found in the good, mechanically supporting characteristics of the two plates of the sandwich component, with respect to one another. The production, processing, and introduction of the solid block of aerogel, in view of the high requirements involved in the handling and processing, and the special care required can be considered disadvantages.

An embodiment with advantages in production consists, on the other hand, of building the core from individual elements in the form of a honeycomb. Thus, individual elements in a hexagonal shape can be introduced between the plates and in this way, a honeycomb-like structure also supporting the two plates against one another can be obtained. The production and handling, on the other hand, are simplified. The production of granules from super-insulating aerogels, which are then introduced between the plates like a bulk material and thus form the core, is completely nonproblematic. The advantages are in the simplicity of the production of the sandwich component and the low-cost production of the granules of super-insulating aerogels used as the starting material. In contrast to this, the disadvantage is to be found in that a mutual mechanical support of the plates with granules placed as a bulk material does not occur. Consequently, these developments are predominantly suitable for application purposes in which the sandwich components have to have a high thermal insulation capacity but, on the other hand, are only slightly loaded mechanically.

An improvement in this regard can be attained by refinements in which crosslinks used for support are placed between the plates. The remaining volume is filled with aerogel.

In a refinement used, in particular, to improve the mechanical characteristics, the aerogel granules or aerogel powder is embedded in polyethylene. Production takes place by mixing aerogel granules and/or powder with a quantity of 5-50 weight-percent polyethylene powder with or without blowing agents and heating to a temperature of 130-180 degrees Celsius, with the result that the aerogel particles are cemented and a compact mass is formed in the sandwich. As a function of the addition of the blowing agent, the mechanical and thermal requirements are fulfilled and a complete chamber filling is attained in comparison with "nonblown polyethylene." With an increasing fraction of the blowing agent, one attains a better thermal insulation. The main goal of the embedding in polyethylene is an improvement of the mechanical characteristics, with a simultaneous acceptance of the worsening of the insulating characteristics.

The low thermal conductivity of aerogels under atmospheric pressure is clearly improved, once again, when used in a vacuum. Particularly favorable values are produced when using the aerogels as vacuum super-insulations, which is realized in that it is embedded in a hermetically closed-off chamber, under a vacuum of ca. 0.01 bar. To avoid deformations, the use of crosslinks for support is of particular importance.

Other details, features, and advantages of the invention can be deduced from the following descriptive section, in which an embodiment example of the invention is explained in more detail, with the aid of the drawing. In schematic representation, a cross-section through an angular component is shown.

Shown is an outer plate (1) and an inner plate (2), which form the outside surface of the sandwich component. For stabilization against pressure loads, crosslinks (3), bridging the interval, are situated, distributed equidistantly.

In-between, there is, in accordance with the proposal of the invention, the super-insulating aerogel (4), which is used for the thermal insulation—that is, a low-density aerogel (4).

As a result, one obtains, with low-cost production, a sandwich component with a high thermal insulation capacity.

Claims

1. Sandwich component for thermal insulation, consisting of two plates, which form the outside surfaces, and a core, which is located inbetween, characterized in that the core is made of super-insulating aerogel (4) (= low density aerogel).

2. Component according to Claim 1, characterized by an undoped aerogel (4).

3. Component according to Claim 1, characterized by an aerogel (4), preferably doped (= made turbid) with iron oxide or titanium oxide.

4. Component according to one of Claims 1-3, characterized by a solid block of aerogel (4).

5. Component according to one of Claims 1-3, characterized by a core built up from individual elements in the form of a honeycomb.

6. Component according to one of Claims 1-3, characterized by granules as the core.

7. Component according to Claim 5 or 6, characterized by crosslinks (3), placed between the plates (1, 2).

8. Component according to one of Claims 1-6, characterized by aerogel granules or aerogel powder, embedded in polyethylene, which is preferably blown and/or foamed.

9. Component according to one of Claims 1-8, characterized in that it is closed off toward the outside and is acted on with reduced pressure in the interior.